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CONTRACT Nonr-1357 (00)

AIRBORNE PERSONNEL PLATFORM

PROGRESS REPORT

JUNE 1956



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HILLER HELICOPTERS
PALO ALTO, CALIFORNIA

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PREPARED	NAME C.H. Dessin	DATE 7/10/56	HILLER HELICOPTERS	PAGE 1
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SUMMARY

Work approached completion under Phase III of Contract Nonr 1357(00) as presently funded and scheduled for completion by 15 July 1956. Phase III was initiated on 1 February to provide additional data relative to performance and control characteristics.

During the month of June, tether flight tests of vertical center-of-gravity location were completed resulting in an appreciable reduction in the amplitude of oscillation and increase in the period of such oscillation. Tests were completed which demonstrated that decoupling of rolling and pitching moment was easily accomplished by making the product of inertia about the vertical axis equal zero. A gyro-bar actuated duct outlet vane control system was completely designed and partially fabricated.

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DISCUSSION

A. WORK ACCOMPLISHED

1. Vertical Center-of-Gravity Tests

Tethered flight tests were resumed on 6 June 1956 with the pilot's floor raised 13 inches above its design elevation. Tests were concluded on 14 June with a maximum floor elevation of 24 inches above the design elevation (having been reached during this test program) with a corresponding vertical center-of-gravity position 23.5 inches above the plane of duct lip for the gross weight condition.

The vertical center-of-gravity was raised by raising the pilot's floor in one inch increments up to the maximum elevation tested. For each floor elevation, tests were conducted by permitting the pilot to make exploratory hovering, translation, forward, backward, and quick stop flight maneuvers. These maneuvers were followed by tests to observe the period and amplitude of oscillation of the platform when displaced angularly by external means and with the pilot fixed rigidly to the machine. Figure 1 shows the limit positions of the vertical center-of-gravity and the pilot's floor tested. Figure 2 is a photograph of the Model 1031A Airborne Platform in the configuration as tested with the highest center-of-gravity position.

The results of the vertical center-of-gravity tests showed that at the 24 inch elevation of the pilot's floor, the platform exhibited an unstable oscillation in pitch with a period of 10 seconds. This oscillation was slower than that for all other positions of vertical center-of-gravity tested. When displaced down at the nose approximately 6 degrees, the platform slowly moved forward, pitching up at the nose 9 degrees followed by horizontal movement aft, pitching nose downward to 9 degrees. The full cycle was timed at 10 seconds.

Earlier tests conducted in the same fashion for a vertical floor elevation of 9 inches above design level with a corresponding gross weight center-of-gravity location of 17.3 inches above the plane of the duct lip showed a full cycle period of 6 seconds for an angular increase of 20 degrees tilt from that of the initial displacement. Figure 3 presents a plot of tilt angle versus time for two typical oscillations at vertical center-of-gravity locations at 17.3 inches and 23.5 inches above the plane of the duct lip.

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The pilot commented that although control of the platform was easily accomplished with the floor at the 24 inch elevation, recovery from forward flight at approximately 18 mph forward speed was noticeably difficult. This reaction of the pilot was believed to indicate that the limit vertical center-of-gravity position had been attained, or very closely approached, as shown by theory (Reference (1), Appendix III) to exhibit a diving tendency. In view of these pilot comments, the floor position was lowered to produce a floor elevation 22 inches above the design location for a corresponding gross weight vertical center-of-gravity position of 22.7 inches. At this elevation of the center-of-gravity, the pilot was quite satisfied with the handling characteristics of the machine. The Project Engineer then flew the platform tethered for four (4) flights of approximately ten (10) minutes duration each and experienced much less difficulty controlling the machine than had been experienced in earlier first attempts with the pilot's floor at the design level. The Project Engineer and the Test Pilot noted no adverse psychological effects associated with the higher pilot position in the machine.

Since studies of the gyro-bar stabilizer device showed that vertical center-of-gravity location would be considerably less critical for a platform employing such a device and since flight had been made apparently bordering on divergent tendencies, no further tests were conducted of vertical center-of-gravity locations.

2. Decoupling Roll and Pitch Tests

Earlier tether tests of the platform showed a definite coupling of roll with pitch and analysis showed this coupling to be primarily due to the dissymmetry of the engine installation as shown in Figure 3. Analysis further showed that by the addition of a certain weight located on the left forward and right aft landing gear leg, as shown in Figure 4, the product of inertia would be zero and no coupling of roll with pitch would be experienced.

During the first tether flight test conducted during this report period, the rolling motion coupled with pitching motion was eliminated by the addition of ballast weights located properly on the platform so as to produce a zero product of inertia about the vertical axis. Tests were conducted with weights of 3.3 pounds, 3.7 pounds, and 4.1 pounds. The 3.7 pound weight produced the best results.

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3. Aerodynamic Fairing of Duct Inlet

In order to improve the static thrust of the platform out of ground effect, as indicated possible by pressure surveys conducted during the last report period (Reference (2)), an attempt was made to clean-up the duct inlet.

Aluminum fairings were made and installed on the engines and the engine support tubes were built up with cardboard and doped tape to give a streamline shape to the round basic tube. For the duct inlet, a streamlined transition shape fairing was built up from cardboard and doped tape. The aluminum fairings were shaped to enclose the sides of the engine (fitting over the cylinder heads) and the back end of the engine which is well out toward the duct wall. This fairing extended down from the top of the cylinder heads in a converging shape to very close proximity to the upper propeller.

Tether flight tests showed only about one foot apparent increase in altitude resulting from this clean-up. The aluminum engine cowling was hoped to provide the most thrust gain by reducing the large amount of reverse flow measured below the engine cylinders; however, tests made with this cowling removed for repairs to fatigue cracks, showed no reduction in hover altitude. All subsequent flight tests were conducted with just the engine tube and tube-duct intersection fairing as shown in Figure 5.

4. Gyro-Bar Stabilizer

A dynamic analysis of a gyro-bar actuated duct outlet vane stabilizer system was completed during this report period. The detail design was completed and parts fabrication was initiated.

This stabilizer device was recommended as the result of stability analyses of the platform which showed that damping in pitch and roll was lacking. This lack of damping is clearly evident by the existence of an unstable oscillation in pitch and roll. The gyro-bar stabilizer was designed as a device employing two pairs of duct outlet mounted control vanes (one set to provide damping in pitch, the other set to provide damping in roll) actuated by two independently hinged, angular rate sensitive gyro-bars. Figure 6(a) presents a sketch of this device which mounts the two gyro-bars on an extension of the lower propeller shaft. By means of a simplified swash plate, the flapping motion of the gyro-bars is transferred from the rotating system to the fixed vanes producing vane pitch settings proportional to bar flapping angle which is proportional to the angular velocity of the platform.

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Figure 6(b) shows the typical operation of the system for the case of the duct pitched down at the nose. The dash lines show the relative position of the bar and vanes to the duct and the lift force "L" so produced by the vanes. This lift force of the vanes causes a damping moment apposing the pitching moment of the platform.

B. PROJECT STATUS

The work accomplished to date represents 96 percent completion of the present Phase III program. An extension of funds and time has been requested by Reference (3) to enable the gyro-bar stabilizer tests and development to continue through September 1956.

C. FUTURE WORK

During the next report period, the month of July, the following work is scheduled:

1. Complete report of stability and control analyses.
2. Completion of fabrication and installation of gyro-bar stabilizer.
3. Tether flight tests of gyro-bar stabilizer.

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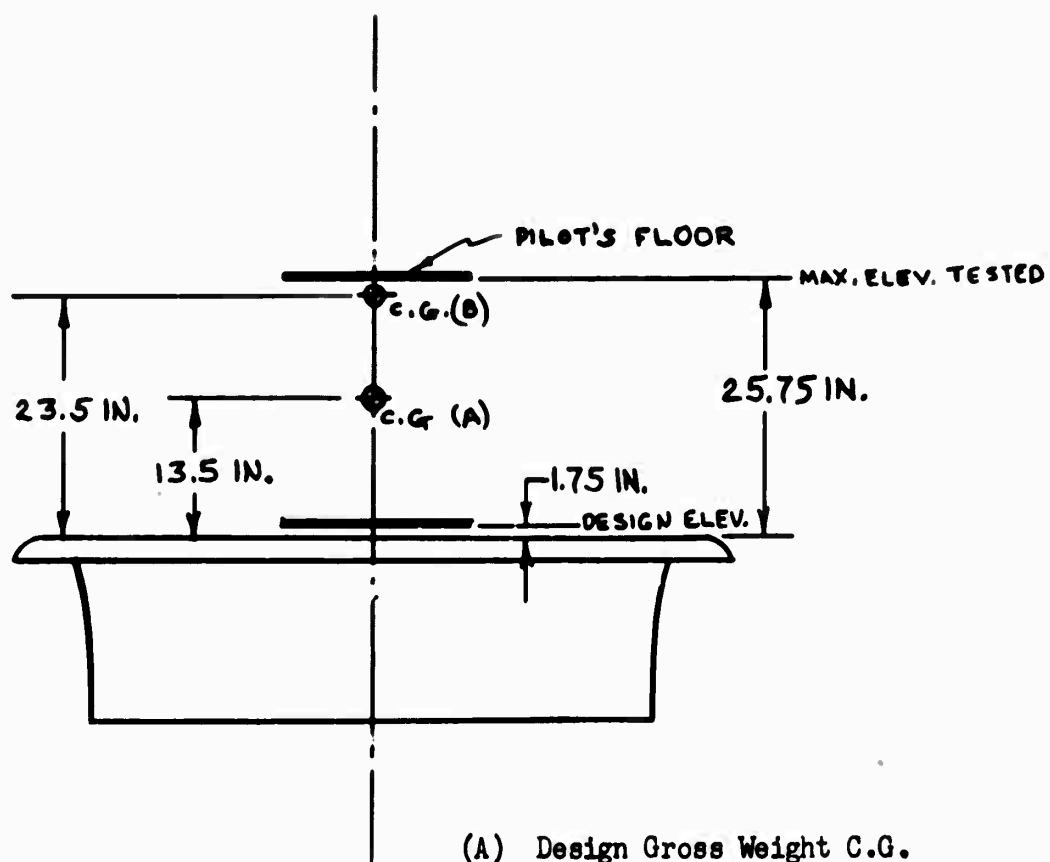
REFERENCES

- Reference (1) Contract Nonr 1357(00), Monthly Progress Report of Airborne Personnel Platform, Month of April 1956, Hiller Confidential Letter No. (C)ME 56-188, dated 22 May 1956.
- Reference (2) Contract Nonr 1357(00), Monthly Progress Report of Airborne Personnel Platform, Month of May 1956, Hiller Confidential Letter No. (C) ME 56-198, dated 15 June 1956.
- Reference (3) Hiller Confidential Letter No. A-24357 dated 1 June 1956, "Contract Nonr 1357(00); Proposal for Additional Work Under Phase III"

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**Airborne Personnel Platform
Contract Nonr 1357(00)**



- (A) Design Gross Weight C.G.
Location
- (B) Maximum Vertical Gross Weight
C.G. Location Tested

FIGURE 1

C.G. AND FLOOR GEOMETRY - C.G. LOCATION TESTS

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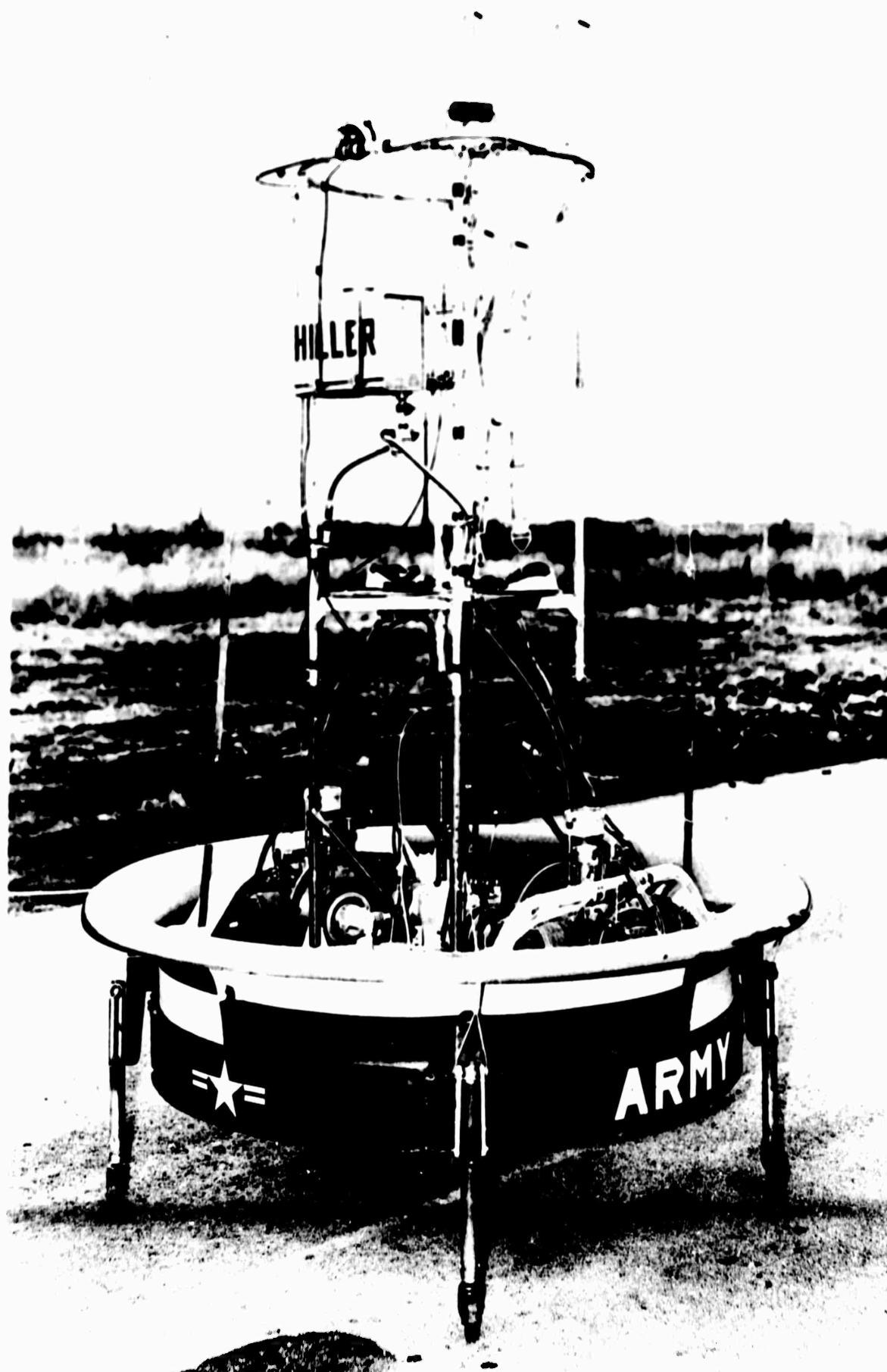


FIGURE 2

MODEL 1031A PLATFORM WITH VERTICAL C.G.
AT MAXIMUM ELEVATION TESTED

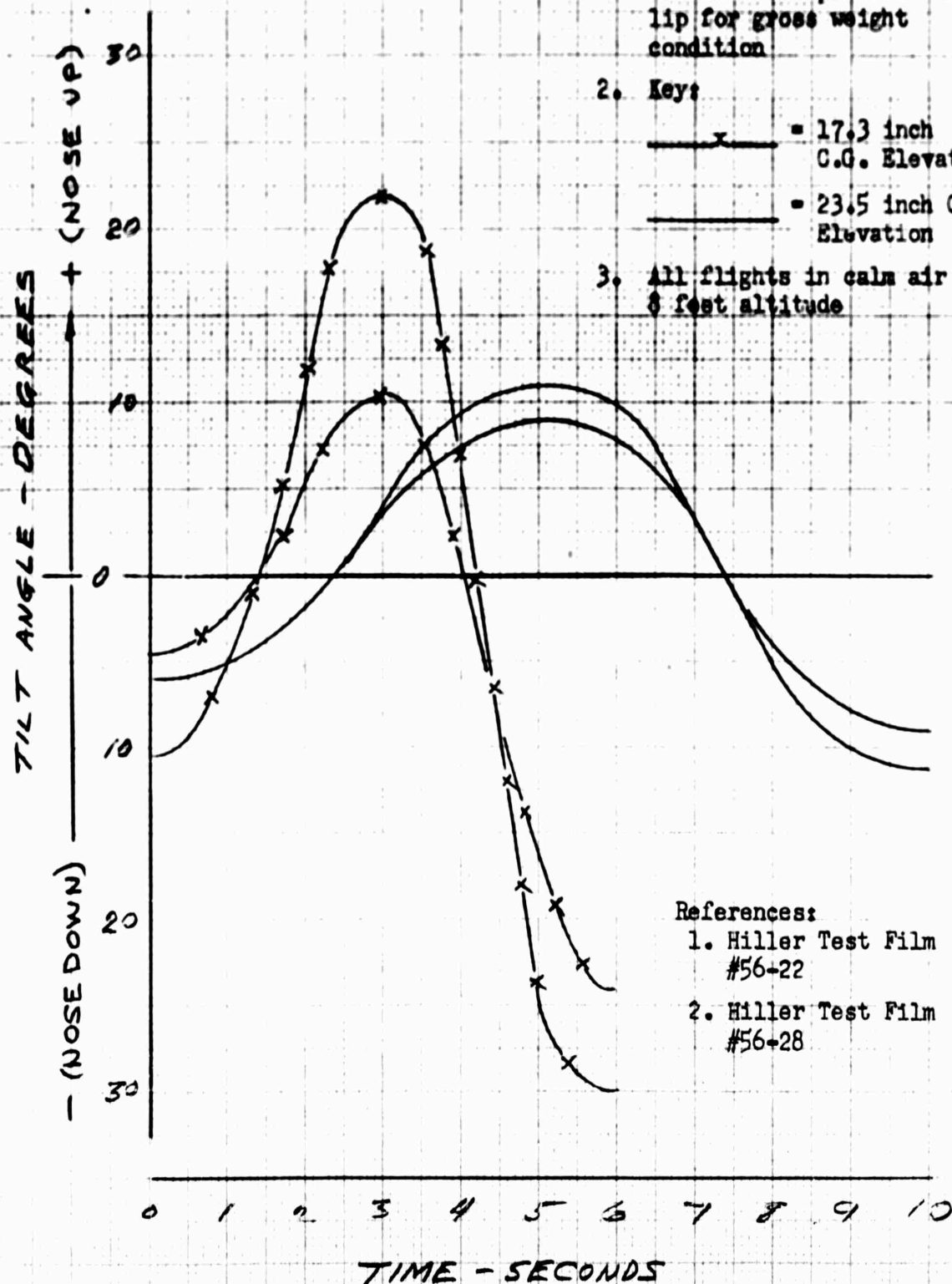
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TILT ANGLE VS. TIME
FOR
MODEL 1031A PLATFORM
WITH VARIOUS VERTICAL C.G. POSITIONS

- NOTES: 1. C.G. positions are in inches above plane of duct lip for gross weight condition
2. Key:
 — x — = 17.3 inch C.G. Elevation
 — — — = 23.5 inch C.G. Elevation
3. All flights in calm air at 8 feet altitude



- References:
 1. Hiller Test Film #56-22
 2. Hiller Test Film #56-28

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FIGURE 3

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Airborne Personnel Platform
Contract Nonr 1357(00)

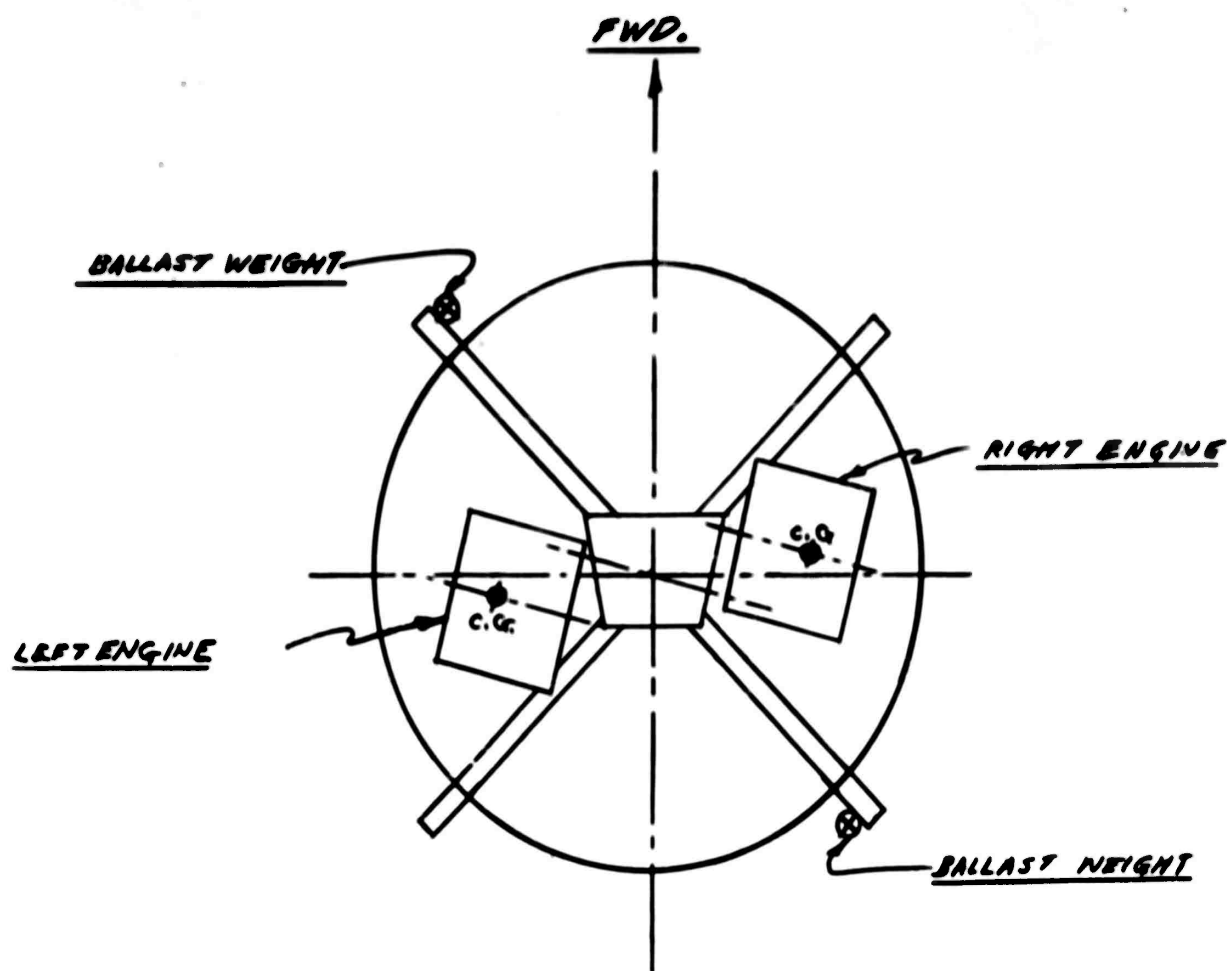


FIGURE 4

PLATFORM GEOMETRY -

DECOUPLING ROLL FROM PITCH TESTS

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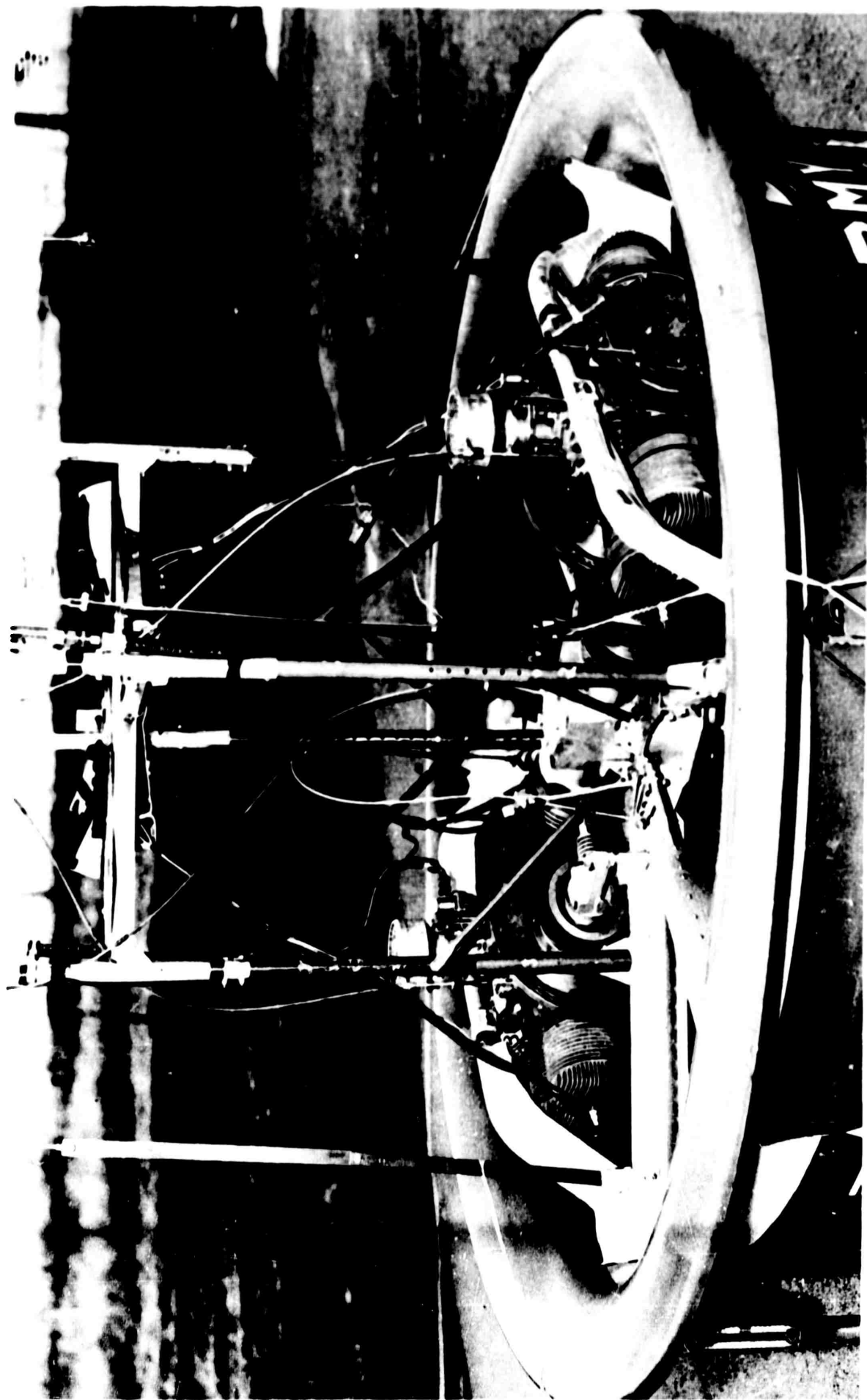
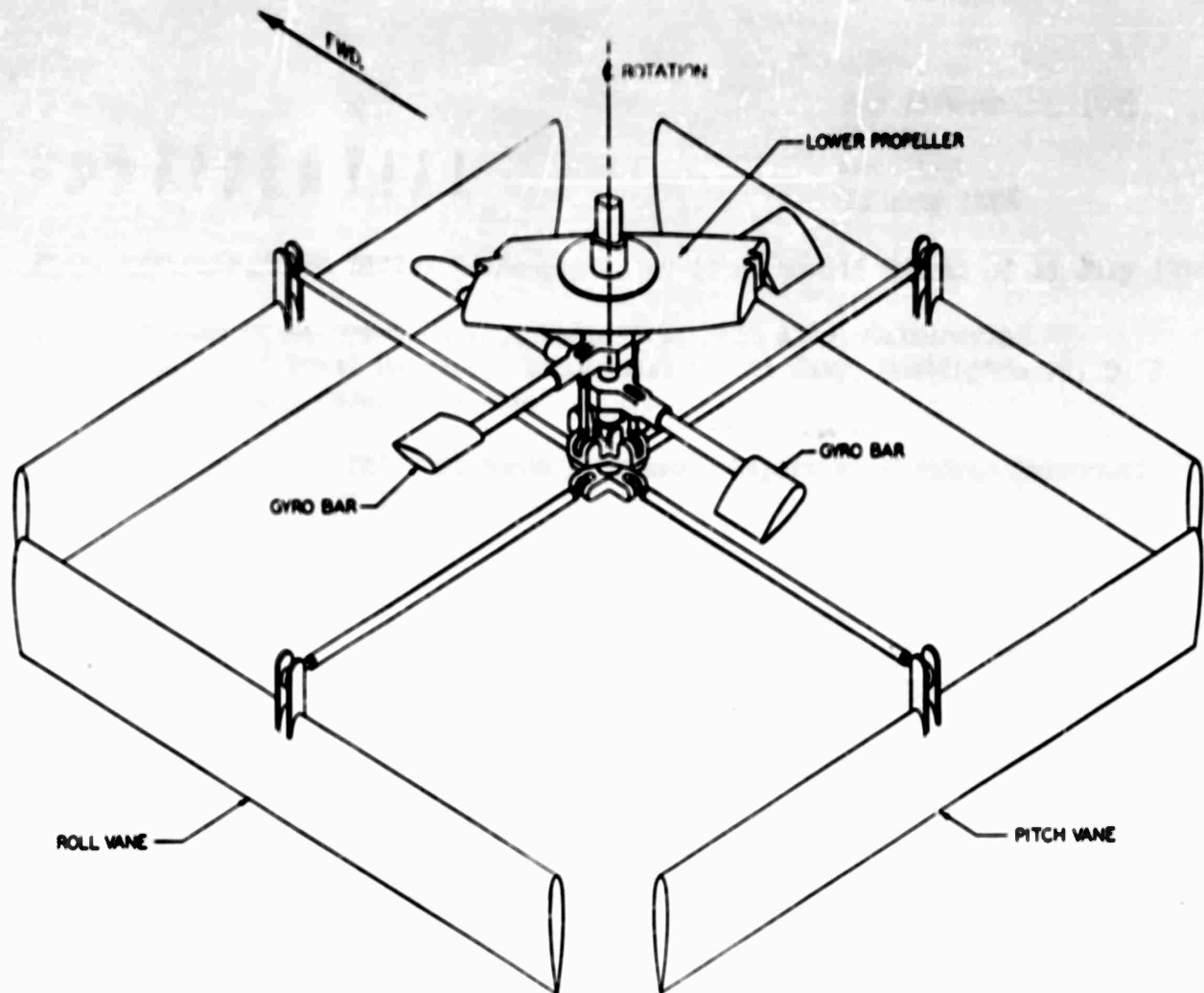


FIGURE 5

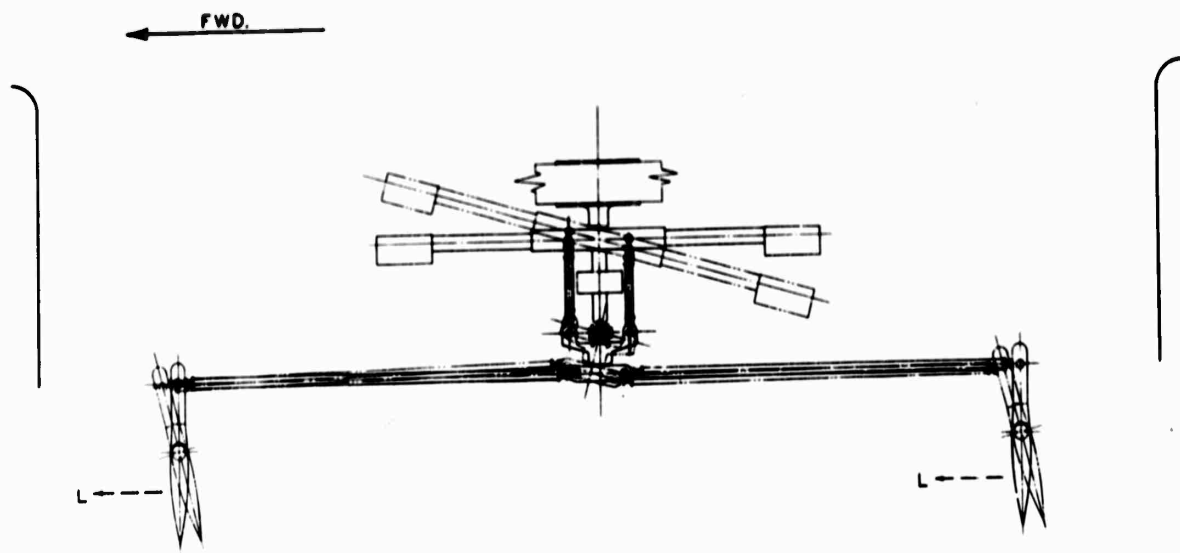
MODEL 1031A PLATFORM
AERODYNAMIC FAIRING OF DUCT INLET

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(A)



(B)

Fig. 6 SKETCH - GYRO-BAR STABILIZER

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19 July 1956

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To: Office of Naval Research, Department of the Navy, Washington 25, D. C.
Attn: Air Branch, Major D. Ritter

Subj: Contract Monr 1357(00) Monthly Progress Report of Airborne Personnel Platform, Phase III

1. Forwarded.



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Acting

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In reply refer to:
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15 July 1956

To: Office of Naval Research
Department of the Navy
Washington 25, D. C.

Attention: Air Branch
Major D. Ritter

Via: Bureau of Aeronautics Representative
Palo Alto, California

Subject: Contract Nonr 1357(00) Monthly Progress
Report of Airborne Personnel Platform, Phase III

Enclosures: (1) Distribution of Reports
(2) Three (3) copies Progress Report
dated 10 July 1956

1. In accordance with the provisions of Contract Nonr 1357(00), Contractor is submitting herewith Progress Report for the Airborne Personnel Platform, covering the period of 1 June 1956 through 30 June 1956.

HILLER HELICOPTERS

W. C. Callaghan
for R. A. Wagner
Chief Engineer

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Enclosure (1) to
(C)ME 56-217

15 July 1956

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